On Taxes and Taxpayers

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Chapter 3

Regional Differences in Applicable Personal Income Tax Rates

3.1 Introduction

Regional differences in taxes have been relevant throughout history. The Persian empire in 500 B.C. already had a system of taxation in place in which different regions (satrapies) were taxed according to specific rules (Kleber, 2015). While these rules applied equally to all regions, productivity differences in various economic areas caused vast differences in the amounts of gold or silver they actually paid (Briant, 2006). A similar case is discussed by Adam Smith, who notes that the king of Prussia taxed his various dominions at an equal rate on the basis of the estimated value of their land. Over time, however, such a tax would rapidly come to have unequal effects, on which Smith notes: "To prevent its becoming so would require the continual and painful attention of the government to all variations in the state and produce of every different farm in country" (Smith 1991/1776, p. 507). Taxes designed to be equitable may over time become untenable, as the Persians found when the Babylonians rebelled in what at least partially was a response to an increase of the tax burden of the Babylonian elite (Kleber, 2015).

In the modern era, individuals are taxed based on their earnings, which are accurately assessed. That is not to say, however, that a common national tax affects all regions in a country equally. There are substantial income differences between regions (Gennaioli et al., 2013). As tax systems are generally progressive, an average individual in a high-income region is effectively taxed at a higher rate than an average individual in a low-income region. These differences can be substantial: in Spain an individual earning the average income in Madrid pays a tax rate approximately 1.4 times higher than an individual living in Extremadura.

These differences in tax rates are likely to have economic effects. Firstly, an

individual's labor supply decision is affected by taxes. When taxes rise, individuals may opt to work fewer hours (Hayo & Uhl, 2015; Kessler & Norton, 2016), be less productive (Kessler & Norton, 2016), and generally reduce their income (Blomquist & Selin, 2010; Heim, 2010; Lehmann et al., 2013). Moreover, across countries higher tax rates are associated with higher unemployment rates (Daveri & Tabellini, 2000; Hausman, 1981; Planas et al., 2007; Triest, 1990). However, the effects of taxes within countries have received less attention. This is remarkable, as there are substantial differences in tax rates between regions, which may result in different macroeconomic outcomes as well.

This chapter provides calculations for the effective average and marginal rates of personal income taxation for an individual with an average income level in 238 regions in 17 European countries, in the period 2000 to 2014. These calculations are made using a country's tax code and take into account not only the tax schedule, but also available deductions and other forms of tax relief for which an average individual would qualify. The computed tax rates vary substantially, both between and within countries. While differences between countries are generally larger, within country differences can still account for approximately 25% of the overall variation in tax rates. In addition, there are substantial differences between countries in the degree to which regional tax rates are dispersed, as well as in the source of this dispersion. In a small number of countries, the differences between regions are relatively small, so that most of the observed variation in tax rates is due to variation in regional income levels over time (gradually moving individuals into higher tax brackets) or tax reforms. In most countries, however, differences between regions are as large or larger than those within regions.

Not only are there large differences in effective tax rates between regions, these differences are also correlated with various key economic characteristics. By using a general-to-specific approach, the relationship between the computed tax rates and a wide variety of variables related to economic geography, economic structure, culture, institutions, and history, is considered. This analysis suggests that, besides obviously having higher levels of income, regions with higher relative tax rates tend to have more favorable labor market outcomes (lower unemployment, higher participation), and a lower agricultural labor share. It also demonstrates that variation in marginal rates is generally harder to explain than that in average rates, as marginal rates tend to be more volatile. A small income change can move an individual into another tax bracket and as such substantially change his applicable marginal tax rate, while leaving his average rate virtually unchanged.

One area where this new data set could be particularly relevant is in the analysis of regional unemployment differentials. As noted above, the effects of taxation on labor market outcomes have been studied at the individual level (Blomquist &

Selin, 2010), as well as the country level (Daveri & Tabellini, 2000), but not at the regional level. To highlight the potential for such an analysis, this chapter demonstrates that there is a strong correlation between the regional tax rate, be it average or marginal, and the regional unemployment rate. Higher regional tax rates are generally associated with a higher unemployment rate, even when employing various control variables and controlling for unobserved differences between regions and countries.

This highlights that understanding effective regional tax rates could be very relevant for policy makers. For one, if a common national tax policy stimulates the labor markets of lagging regions at the expense of leading regions, this would facilitate regional convergence. Such regional convergence has in recent years been a key policy objective of the European Union (European Political Strategy Centre, 2015), and also features highly on the agenda of various member states, such as Germany (Jansen, 2004). To achieve convergence, however, the focus has been mostly on the spending side of public policy, i.e. explicitly transfering funds from higher- to lower-income regions. While this focus may be justified, it should be recognized that such goals could also be attained, or at least be supported, by tax policy.

This chapter proceeds as follows. Section 3.2 discusses the literature on different tax measures, and makes the case why taxation should also be considered from a regional perspective. Section 3.3 outlines how the regional tax rates are computed and is supported by country-specific details provided in the Chapter Appendix. Section 3.4 continues with a description of the calculated rates and examines the extent to which these vary across regions, countries, and time. Section 3.5 examines which factors can account for the observed within-country variation in tax rates. Section 3.6 uses the data set to explain observed differences in regional unemployment rates. Lastly, section 3.7 concludes the chapter.

3.2 Literature Review

3.2.1 Aggregate Tax Rate Measures

Studying the impact of taxation on individual behavior or on macroeconomic outcomes requires accurate measurement of tax burdens. For this there are essentially two main measurement approaches. First, average rates, refered to as effective or implicit tax rates, can be estimated from macroeconomic data (Volkerink & de Haan, 2001). Second, the applicable tax rates can also be derived directly from the tax code. Such statutory tax rates, which are essentially marginal rates, can be used in combination with information on tax deductions and credits to compute an average

rate of personal income taxation, denoted the all-in rate (OECD, 2000). As such, the main difference between the two approaches is that the effective rate is based on the actual amount of taxes paid, whereas the all-in, or applicable, rate is based on the amount that should be paid. A further difference is that approaches based on statutory or all-in rates are typically calculated for those entities that actually pay the taxes, such as corporations or persons (Easterly & Rebelo, 1993; Widmalm, 2001). Effective tax rates can also be calculated for these, but the approach extends to taxes on factors of specific interest to macroeconomic research, such as capital, labor and consumption (Daveri & Tabellini, 2000; Mendoza et al., 1994).

The approach of obtaining estimates of effective tax rates from macroeconomic data was started by Mendoza et al. (1994), extended in Mendoza et al. (1997) and refined in OECD (2000) and Volkerink and de Haan (2001). An effective rate is essentially the ratio of the total of all tax revenue from a particular source to (an estimate of) its tax base. For personal income taxation this would thus be the ratio of all revenue collected from personal income taxation to all personal income. As noted by Volkerink and de Haan (2001), however, while tax revenue can typically be properly classified to a certain source, it is more difficult to capture the corresponding income (or tax base) over which the tax is levied. For example, measures of firm income may include the income of unincorporated enterprises. These enterprises, however, do not pay corporate income taxes and their income should thus not be included in the tax base of a corporate income tax. While the issue of capturing the right tax base is substantial, the method does have the advantage of producing measures that can be easily compared across countries, since they are constructed in exactly the same way in each country. Empirical analyses have employed these effective rates in studies of economic growth and labor markets. This methodology is also employed in **Chapter 2** of this thesis.

Calculating all-in rates of personal income taxation directly from the tax code is a complicated process. In general, countries have tax schedules that consist of more than one tax rate that is applied to specific income brackets. This is further complicated by differences regarding the amount of income over which taxes are due, and the existence of tax credits, which are subtracted from the tax bill. The OECD's annual Taxing Wages report (OECD, 2000-2014) summarizes the relevant parts of each country's tax code and uses the information to estimate tax burdens for different household types and income levels. Despite the differences in tax systems between countries, this does lead to a set of tax rates that are consistently computed and can be compared across countries. Moreover, this information can be used to calculate tax burdens at any income level of interest. This data set and its methodology have been employed by, among others, Algan, Cahuc, and Sangnier (2016), Egger and Radulescu (2009), and Kleven, Landais, and Saez (2013), in various contexts. In

principle, rates calculated this way are more accurate than those estimated using the effective rate methodology (Volkerink & de Haan, 2001).

The discussion thus far has primarily focused on average rates of taxation. In many cases, however, a marginal rate may be of much greater interest. The effective taxation methodology can be used to estimate average tax rates, but the computation of an effective marginal rate is much more elusive. As such, effective tax rates can typically only serve as an approximation of the marginal rate (Mendoza et al., 1994). For an approach based on statutory rates, however, this is not the case. If the data permits the estimation of the average rate of personal income taxation, it also permits the calculation of the marginal rate. After all, if the tax burden at an income level of X can be calculated, it can also be calculated at $X + 1$, with the difference between them being the marginal rate.

3.2.2 Regional Variation in Tax Rates

There is substantial evidence that many macroeconomic variables show as much variation within countries as between countries. This is true for unemployment rates (Taylor & Bradley, 1997), participation rates (Elhorst & Zeilstra, 2007), economic development (Gennaioli et al., 2013), GDP growth (Sala-i Martin, 1996), total factor productivity (Beugelsdijk, Klasing, & Milionis, 2017a), and various cultural factors (Beugelsdijk, Klasing, & Milionis, 2017b; Schwartz & Sagie, 2000). However, theories which explain the cross-country variation in such variables often cannot account for regional differences. For example, Elhorst (2003) notes that macroeconomic studies have typically identified labor market institutions as being the major explanation for observed differences in the unemployment rate across countries. However, such institutions do not differ greatly between regions within a country, so they cannot explain disparities in regional unemployment. In addition, there is in general a potential for biased inferences when studying between-group differences while not accounting for differences within-groups (Au, 1999). Both of these issues make it desirable to study variables with a substantial degree of regional variation at the regional level.

It is not immediately obvious that taxation would fall into the category of variables exhibiting high variation across regions. Indeed, the effects of taxation have been studied at both the individual level and at the country level, but not at the regional level. In general, regulations set at the country level apply equally to all regions within a country and as such cannot be expected to explain regional differences (Elhorst, 2003). However, a set of rules may apply equally in all regions yet not affect each region equally. For the case of taxes, there are large income differences between regions within countries (Gennaioli et al., 2013). The average citizen

in one region may thus have a substantially higher income level than the average citizen in another region. By implication, given a system of progressive taxation, the average and marginal tax rates that they face may also be very different.

Since taxes have been demonstrated to affect both individual labor supply as well as macroeconomic outcomes, examining personal income taxation from a regional perspective could be very relevant. For one, as citizens in higher income regions are taxed at a higher rate than citizens in a lower income region, national level tax policy may facilitate regional income convergence. Moreover, if taxes influence an individual's labor supply decision, there could be differences as well in how taxes affect different regional labor markets. A systematic study of such differences in tax rates between regions has, to the best of my knowledge, never been considered in the literature and as such is the main contribution of this chapter.

3.3 Calculating Regional Tax Rates

While the tax systems across EU countries can differ to a large degree, the core principles of taxation are the same. The starting point is always an individual's earnings, from which certain deductions are subtracted. Over the remainder, the tax schedule (which typically consists of various income brackets that are taxed at different rates) is applied, resulting in a tax liability. Any available tax credits may then be applied in order to arrive at the actual amount of taxes that is due. In a similar manner, the amount of social security contributions (SSC) are computed, which, when added to the amount of taxes that are due, yield the total payments to the general government. Expressed relative to an individual's income this yields the average tax rate. Table 3.1 summarizes these steps using figures for Hungary and Belgium as examples.

One of the simplest tax systems is that of Hungary in recent years. An example of how the process of taxation described above works in practice is shown on the middle of Table 3.1. The average Hungarian citizen in 2014 has an income of Ft 3,053,364. There are no deductions, so his taxable income is the same amount. Hungary has a system of flat taxation in which all income is taxed at a rate of 16%. As such, the tax liability would in this case be $0.16 \times \text{Ft } 3,053,364 = \text{Ft } 488,538.24$. Then, since there are no tax credits either, the amount of taxes due is also Ft 488,538.24. Similarly, social security is levied at a flat rate of 18.5% over the same base. As such, the amount of SSC to be paid is $0.185 \times \text{Ft } 3,053,364 = \text{Ft } 564,872.34$. Combined with the tax burden, this gives a total amount of payments to the general government of Ft 1,053,410.58, for an average total tax rate of 34.5%. Since this rate applies to any and all income, it follows that the marginal rate is also 34.5%.

Similar calculations for any other country or year are substantially more com-

Table 3.1: Process of Taxation

		Hungary (2014)	Belgium (2014)
Estimate income (gross wage)	(1)	Ft 3,053,364	€46,465
Apply deductions	(2)	Ft 0	€9,479.53
(1)-(2) = Taxable income	(3)	Ft 3,053,364	€36,985.47
Apply tax schedule to (3) = Tax liability	(5)	Ft 488,538.24	€14,919.51
Apply tax credits	(6)	0	€1,768
(5)-(6) = Taxes due	(7)	Ft 488,538.24	€13,151.51
Apply SSC schedule to (1) or (3) =SSC due	(8)	Ft 564,872.34	€6,216.00
(7)+(8) = Total payments to the government		Ft 1,053,410.58	€19,367.51
Average tax rate		34.5%	41.7%
Marginal tax rate		34.5%	54.0%

plicated. Consider Belgium, described in the right-most column of Table 3.1. The average Belgian in 2014 has an income of €46,465. There are a number of deductions available to him. First, SSC at a rate of 13.07% may be deduced from his income. In addition, there is a fixed deduction of €2,579 and an income dependent deduction of 3% of all income above €18,880. Combined these deductions total €9,479.53. His taxable income thus equals €36,985.14. To this amount the tax schedule is applied, which unlike in Hungary consists of various brackets. Over the first €8,680 a rate of 25% is applied. Income between €8,680 and €12,360 is taxed at 30%. Income between €12,360 and €20,600 at 40%, and the remainder of his income is taxed at 45%.[1] This results in a tax burden of €13,943.46. However, Belgium has an additional surcharge that essentially serves as a municipal tax. This surcharge of 7% is levied over the entire tax burden, yielding a total tax liability of €14,919.51. From this a fixed tax credit of €1,768 may be subtracted, so that the total amount of taxes due is €13,151.51. Social security payments are relatively straightforward to compute, since as noted above they equal 13.07% of the gross wage. However, there is an additional social security levy of €223 plus 1.3% of taxable income in excess of €21,071. The total SSC due is thus €6,216. Combined with the taxes due, this implies a total payment to the general government of €19,367.51, for an average tax rate of 41.7%. The marginal tax rate can most easily be computed by repeating the above calculation at an income level that is €1 higher and noting the change in the tax burden. In this case it is 54.0%.

The examples for Hungary and Belgium highlight that there are major differences

[1]There is an additional tax bracket for income above €37,750 of 50%, which does not apply in this case.

in the way deductions and tax credits are calculated. In the simplest case, both deductions and tax credits are a fixed amount, which does not vary at all from one individual to the next and does not depend on income. This is the case in Hungary, as both numbers are zero for all individuals. In many countries, like Belgium, one or both do depend on income. Deductions and tax credits may be a fixed percentage of income, or a fixed amount that is only available for individuals below a threshold. Quite a few countries have a deduction or tax credit that has a certain baseline value which is linearly reduced to zero as income rises.

A country's tax schedule typically consists of a number of tax brackets to which different tax rates apply, as is the case in Belgium. This thus means that an individual pays a certain tax rate over a certain share of his income, and a different tax rate over another share. In practice, almost every country has a progressive system of taxation, so that taxes are higher for higher income levels. The two exceptions to this rule are Hungary and the Czech Republic, both of which have (in recent years) adopted a system of flat taxation.[2] An exception of a different kind is Germany, which has a system of progressive taxation but does not work with brackets. Instead, income taxation is entirely formula-based, with different equations specifying the tax burden for different income levels.

For the purpose of the analysis in this chapter, social security contributions (SSC) are treated like taxes. While an argument can be made that SSC are not really taxes, but insurance payments, in practice there is not much difference with taxation in general. Specifically, in many cases SSC are not earmarked for specific expenditures, nor are an individual's payments generally linked to his own potential benefits. Moreover, SSC are typically levied over (almost) the same tax base as general taxation, and in some cases, such as in the Netherlands, entirely included in the regular tax schedule. Lastly, parts of social security are financed in different ways in different countries. As such, what is paid for by means of SSC in one country may be paid for by general taxation in another. It is therefore practically impossible to objectively classify SSC in different countries as being more or similar to a tax (OECD, 2000). All SSC are thus included into an overal rate of taxation, in order to facilitate comparisons across countries.

The OECD's Taxing Wages reports (OECD 2000-2014) contain detailed information on all of the elements described above on a yearly basis. A discussion of some of the peculiarities of the different tax systems is included in the Chapter Appendix. Moreover, the OECD also publishes a data set with rates of personal income taxation in different countries and at different income levels. Given an individual's income level, family structure, and country of residence, these reports combined

[2]In the Czech Republic, average tax rates do increase as income rises, as the flat tax only applies to income above a certain amount.

with the data set contain all the necessary information to calculate his tax burden. By looking at the income levels of individuals residing in different regions within the same country, it is thus possible to estimate tax rates for different regions.

3.3.1 Household Structure and Income

Personal income taxes are generally paid at the household level, as (a.o.) married couples generally find it beneficial to file their taxes together. In many countries, some form of tax relief is granted only to married couples. Moreover, most countries grant some form of relief for individuals or couples which have dependents. The differences between countries in such forms of tax relief are substantial. Combined with the fact that there are also differences in household structure between countries, it is clear that this complicates comparisons of tax rates across countries. For this reason, the unit of analysis here shall be a household that consists of a single individual who has no dependents, which is also the choice made for the exposition by the OECD (2000).

While the OECD publishes estimates of earnings for different kinds of households, such estimates are not typically available at the sub-national level. Data on household income in general, however, is available. The finest level at which this data is available is the NUTS-2 level[3], which is therefore the level of analysis used here. Since households generally consist of more than one individual, this data has to be rescaled in order to have an estimate of a single individual's earnings. The approach taken here is to compute the ratio between the OECD's earnings estimate of an average single individual and per capita household income. This ratio varies little from country to country or year to year and is typically in the 1.5-1.8 range. This ratio is computed for every country and every year, and is subsequently used to scale household income to that of a single individual. For this approach to be valid, it relies on the assumption that the relationship between the earnings of households and single individuals are the same for all regions within a certain country and in a specific year.[4] As an alternative approach, which does not require rescaling, it is also possible to use GDP per capita as a rough estimate of individual earnings. At the national level this tends to be very similar to the OECD's earning estimate. Data for both regional household income and regional GDP is obtained from Eurostat.

[3]In most countries the NUTS 2 level corresponds to first-level administrative regions.

[4]Differences between countries or through time are not a problem, since the ratio is computed for every country and year separately.

3.4 Data Description

Using the method described in the previous section, I have calculated average and marginal rates for personal income taxation as they apply to citizens earning an average income in their region of residence. For the sake of simplicity, these rates shall henceforth be referred to as regional tax rates, or even merely the tax rate, unless this usage may cause confusion in a given context. The data set covers 238 regions across 17 European countries, for the period 2000 to 2014. In some cases, the period covered is shorter as regional income data is not available for some years (notably Belgium and Ireland in 2000 and 2001). This section shall proceed with a summary of the results of this approach, examining the obtained average and marginal tax rates.

3.4.1 Country Level

Table 3.1 summarizes the average and marginal tax rates at the country level. The values reported for each country are the rates applicable at the mean national income level, averaged over the period 2000 to 2014. The first two columns show the calculations based on the approach outlined above, using either per capita household income (in column one) or per capita regional GDP (in column two) as the basis. The third column contains the OECD estimate of the average tax rate in these countries. Comparing the numbers for the same country in the different columns serves as a valuable cross-check, as large differences indicate potential issues. Columns four through six repeat this exercise for the marginal tax rate.

Contrasting first the estimates of the average tax rate, it is clear that the calculated rates, based on either household income or GDP, are very similar to the estimates of the OECD. On average, taxes appear to be the highest in Belgium and Germany, which are the only countries where an individual earning an average income faces an average rate of 40% or higher. On the other end of the spectrum, Ireland is the only country where this rate is lower than 20%, although Spain and Portugal come close. In general, the results based on household income seem to perform slightly better than those based on regional GDP, as the difference with the OECD calculations is smaller, although not to any great extent. Examining this on a per country basis, however, shows that in some cases the deviations are more substantial. For Ireland, for example, the estimate based on GDP exceeds the OECD estimate by approximately 3 percentage points. Similarly, for the United Kingdom the estimate is some 3 percentage points lower. As such, household income seems to be a better measure of individual earnings than GDP per capita. The rates calculated using household income seem very much in line with OECD estimates.

Moving on, a similar set of numbers is presented in columns four, five, and six

Table 3.1: Average and Marginal Tax Rates: 2000-2014 Averages

Country	Avg. Tax Rate (hhinc)	Avg. Tax Rate (GDP)	Avg. Tax Rate (OECD)	Marg. Tax Rate (hhinc)	Marg. Tax Rate (GDP)	Marg. Tax Rate (OECD)
Austria	0.388	0.373	0.371	0.548	0.545	0.512
Belgium	0.442	0.415	0.424	0.555	0.540	0.558
Czech Republic	0.230	0.253	0.230	0.309	0.318	0.309
Denmark	0.374	0.368	0.383	0.438	0.439	0.460
Finland	0.313	0.305	0.308	0.451	0.443	0.452
France	0.296	0.279	0.283	0.435	0.424	0.410
Germany	0.400	0.366	0.414	0.527	0.489	0.560
Greece	0.248	0.221	0.245	0.395	0.361	0.383
Hungary	0.353	0.380	0.355	0.395	0.410	0.570
Ireland	0.163	0.236	0.170	0.332	0.403	0.336
Italy	0.302	0.302	0.295	0.405	0.405	0.397
Netherlands	0.339	0.314	0.324	0.479	0.472	0.473
Poland	0.289	0.287	0.264	0.314	0.314	0.289
Portugal	0.233	0.237	0.230	0.366	0.366	0.363
Spain	0.211	0.206	0.209	0.316	0.321	0.312
Sweden	0.284	0.287	0.284	0.403	0.416	0.399
United Kingdom	0.260	0.238	0.257	0.325	0.325	0.321
Average	0.301	0.298	0.297	0.414	0.414	0.415

Applicable tax rates are calculated at the national average income level, using either household income (hhinc) or GDP per capita. Estimates from the OECD are also reported.

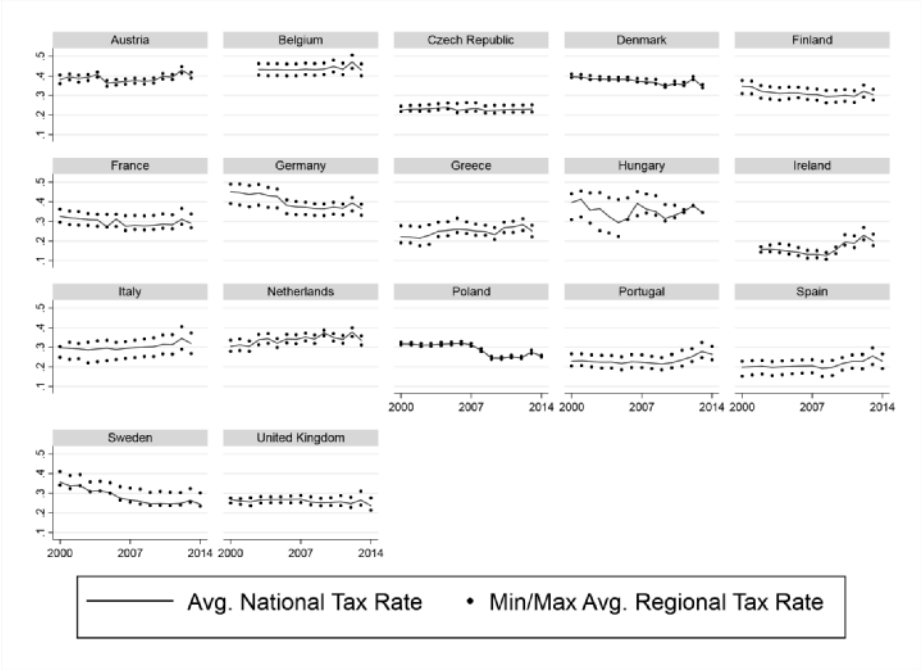
with the marginal rates. Here too, the calculated rates are generally similar, although the estimates based on household income are closer to those of the OECD. Marginal rates are by their nature more volatile than average rates, as a relatively small change in income can imply a substantial change in the corresponding marginal rate. This is evident from the numbers presented here, as for some countries there are more sizable differences between my estimates and those of the OECD. This is particularly the case for Hungary, where my calculated rate is almost 18 percentage points lower. This large difference appears to be the result of the OECD's calculations for an individual at the average income, which I cannot replicate for some years. For example, in 2011 the reported marginal tax rate for an individual earning 100% of the average income is 53.1%. At the same time, however, at 67% of the average income this is only 37.8%, which is the same rate as at 167% of the average income. These 37.8% values are in line with my calculations, whereas I cannot replicate the 53.1%. For this reason, combined with the fact that the estimates for the average tax rate are consistent, I will argue that my numbers here are more accurate.

The rates presented in Table 3.1 are averaged over the period 2000 to 2014. For most countries, these tax rates are relatively stable over time. Consider Figure 3.1, which shows the evolution of the average tax rate (calculated on the basis of household income). Moreover, differences within countries are illustrated by the lowest and highest estimated regional average tax rates. In the absence of major tax reforms, the average rate would trend gradually upwards, as economic growth raises the average income level and, by merit of progressive taxation, the average tax rate as well. In most countries, average rates have indeed increased a bit over this time period.

Some notable exceptions to this trend are the Nordic countries, as well as Germany and Poland, where average tax rates have gradually fallen. This is most notable in Sweden, where average tax rates have fallen from around 34% in the year 2000, to just under 25% in 2014. For Sweden, the graph furthermore illustrates that the applicable tax rate in most regions is very close to the national average, with only a few regions have a significantly higher income level and thereby applicable rate. The graph for Hungary stands out as well. Prior to 2009, the spread in average rates between regions was rather large in Hungary, owing due to similarly substantial income differences and a tax system with relatively high marginal rates. After 2009, however, a transition was started towards a system of flat taxation, which was completed in 2013. Naturally, this implies that there is no further variation in regional tax rates after this point. Lastly, it is clear that there are substantial dif-

[5] In particular it is relevant how progressive the tax system is for income close to the average income level.

Figure 3.1: Average Tax Rates and Regional Dispersion Over Time



ferences between countries in the spread of the tax rates, which is driven by income differences within a country and how progressive the tax system is.[5] Here Poland stands out especially, as it has a relatively flat system of taxation and small income differences between regions, so that the differences between the lowest and highest regional tax rates are small. This is also true for Denmark, although the numbers presented here possibly understate the extent of the regional variation.[6] Conversely, the rates in Italy are more dispersed, resulting from substantial income differences between the northern and southern parts of the country.

On the whole, the figures presented in this section show that the approach used in this chapter to calculate regional tax rates leads to accurate estimates. The average of the calculated regional rates is very similar to OECD estimates of the average and marginal tax rate at the national level. This cross-check thus suggests that the approach is reliable. In addition, it seems that in most countries the tax rates are quite stable over the time period studied. There appears to be substantial differences in how dispersed regional rates are in different countries. This regional variation is described in further detail in the next section.

[6]This is due to the presence of substantial taxes at the municipal level, explained in more detail in the Chapter Appendix.

3.4.2 Variance Decomposition

The dispersion of average regional tax rates is documented in Table 3.2. For each country, this table shows the mean average tax rate, also reported in Table 3.1, and the coefficient of variation. This variation is then subsequently decomposed in the variation between regions and within regions. In addition, the range of the observed values between and within regions is reported to further summarize the extent of regional dispersion.[7] The final column lists the number of observations per country. Lastly, at the bottom of this table a similar variance decomposition between and within countries, based on averages over the entire period, is reported.

Looking at the coefficient of variation for the different countries makes clear that (1) there is substantial variation in tax rates within countries, and (2) the extent of this variation is much larger for some countries than for others. For Belgium, for example, there is very little variation in average tax rates over time and across regions, which could also be glanced from Figure 3.1. In Ireland, on the other hand, there is a substantial increase in the average tax rate in the same period, leading to much more variation. While the coefficient of variation highlights some differences between countries, it masks others. Consider the values for Poland and Finland in Figure 3.1. In Poland, there is very little regional dispersion, so that almost all of the variation in the average tax rate comes from changes over time. In Finland, however, differences between regions are much larger, while there is less change over time. Even so, both countries have an almost identical value for the coefficient of variation.

For this reason, it is a valuable exercise to do a variance decomposition, to specify to what extent the observed variation is between regions, and to what extent it is within regions, i.e. over time. This between and within decomposition is reported in columns four and five of Table 3.2. The between share reported here is the ratio of variance between regions to the overall variance. Similarly, the within share is the ratio of the variance within regions to the overall variance.[8] This decomposition shows very clearly that in Poland almost all of the variation in the average tax rate occurs within regions, since the within share is close to 1, while in Finland the variation between regions is much larger as indicated by the higher between share.

To further capture the extent of variation between and within regions, columns five and six report the corresponding ranges. A higher value indicates a wider range. For example, a value of 0.05 means that the difference between the minimum and

[7] Specifically, the reported range is the difference between the maximum and minimum value.

[8] Note that since the panel is unbalanced, the shares do not generally add up to 1. This is further exacerbated by the $n/(n-1)$ term that is used to calculate an unbiased variance estimate. The overall and within variance are calculated with n equal to the total number of observations. The between variance is calculated with n equal to the number of groups, i.e. regions, which is much smaller.

Table 3.2: Variance Decomposition of the Average Tax Rate: Between and Within Regions

Country	Mean Average Tax Rate	Coefficient of Variation	Between Share	Within Share	Between Range	Within Range	Obs
Austria	0.388	0.051	0.233	0.792	0.029	0.010	135
Belgium	0.437	0.048	0.741	0.322	0.060	0.005	132
Czech Republic	0.229	0.053	0.906	0.201	0.034	0.005	120
Denmark	0.375	0.047	0.172	0.861	0.018	0.007	75
Finland	0.311	0.092	0.881	0.286	0.061	0.016	75
France	0.293	0.071	0.377	0.639	0.066	0.018	330
Germany	0.397	0.099	0.258	0.749	0.079	0.026	570
Greece	0.246	0.107	0.362	0.665	0.054	0.042	195
Hungary	0.348	0.139	0.550	0.524	0.103	0.063	105
Ireland	0.167	0.243	0.584	0.696	0.044	0.185	26
Italy	0.299	0.115	0.760	0.274	0.093	0.039	315
Netherlands	0.337	0.075	0.329	0.696	0.046	0.019	180
Poland	0.288	0.106	0.014	0.987	0.014	0.029	240
Portugal	0.230	0.118	0.660	0.429	0.066	0.039	105
Spain	0.209	0.123	0.622	0.409	0.072	0.045	285
Sweden	0.287	0.151	0.251	0.778	0.065	0.060	120
United Kingdom	0.258	0.053	0.493	0.520	0.040	0.014	525
Overall[a]	0.302	0.233	1.059	0.255	0.280	0.094	238

[a] Decomposition between countries and regions, using averages over 2000-2014. The between and within shares are the ratio of the between or within group variance to the overall variance. The between and within ranges are the difference between the maximum and minimum observed values between or within groups.

maximum value is 5 percentage points. If for a country the between range is much larger than the within range, this suggests that there are more differences in the extremes between regions than over time. Combined with the variance decomposition, this provides a good description of the variation in the data.

Based on these values, the countries can be roughly divided into three groups. First, there are countries in which the variation between regions is relatively small, so that most of the variation occurs within regions. These countries are Austria, Denmark, Germany, Ireland, the Netherlands, Poland, and Sweden. For these countries, the main source of variation in the tax rate is either tax reform, or GDP growth. Second, there are countries where the variation between regions is relatively large compared to that within them. These are Belgium, the Czech Republic, Finland, Italy, Portugal, and Spain. In these countries the differences in tax rates are mainly due to income differences between regions. Third, in the remaining countries the variation between and within regions is of similar size. These countries are France, Greece, Hungary, and the United Kingdom.

The bottom row of Table 3.2 conducts a similar variance decomposition, but not between regions and years, but between countries and regions. Using average values for 2000-2014, this quantifies how big the variation in tax rates is between and within countries. Unsurprisingly, the variation between countries is substantially larger. Even so, the variation within countries is still substantial. The values for the between and within ranges suggest that the difference in average tax rates between the highest and lowest tax country is roughly thrice as large as the biggest difference observed within a certain country.

A similar analysis can be conducted on the basis of the marginal rates, which is reported in Table 3.3. Depending on a country's tax code, there can be substantially more or less variation in marginal rates than in average rates.[9] The same is true for differences between regions. For the coefficient of variation roughly the same pattern as in Table 3.2 emerges. A notable exception is the United Kingdom, where there is substantially more variation in marginal rates than there is in average rates. This occurs because the tax brackets happen to be close to the observed regional income levels.[10] To a lesser extent this is also true for Sweden and Denmark. In other countries, such as Austria and the Netherlands, there is substantially less variation in marginal rates than in average rates, as regional income values fall mostly into the same tax bracket.

Looking at the decomposition of the variance between and within regions it is clear that here too the values tend to be more extreme, as in none of the countries

[9] A small increase in income can lead to a dramatic increase in the marginal rate. Alternatively, a large increase of income could also potentially lead to no change whatsoever in the marginal rate.

[10] As a result regions with similar income levels may have different marginal rates, if one is just below and the other just above a higher tax bracket.

Table 3.3: Variance Decomposition of the Marginal Tax Rate: Between and Within Regions

Country	Mean Average Tax Rate	Coefficient of Variation	Between Share	Within Share	Between Range	Within Range	Obs
Austria	0.546	0.032	0.083	0.926	0.015	0.008	135
Belgium	0.560	0.050	0.638	0.416	0.045	0.009	132
Czech Republic	0.304	0.063	0.178	0.843	0.025	0.017	120
Denmark	0.454	0.076	0.961	0.221	0.076	0.020	75
Finland	0.460	0.066	0.716	0.420	0.051	0.011	75
France	0.478	0.109	0.099	0.906	0.053	0.053	330
Germany	0.508	0.120	0.077	0.925	0.053	0.056	570
Greece	0.384	0.103	0.191	0.823	0.060	0.048	195
Hungary	0.386	0.263	0.177	0.847	0.112	0.253	105
Ireland	0.373	0.309	1.384	0.280	0.192	0.247	26
Italy	0.423	0.134	0.358	0.658	0.085	0.084	315
Netherlands	0.479	0.048	0.114	0.895	0.031	0.020	180
Poland	0.314	0.108	0.000	1.000	0.000	0.028	240
Portugal	0.374	0.111	0.261	0.774	0.056	0.055	105
Spain	0.315	0.091	0.334	0.682	0.047	0.040	285
Sweden	0.377	0.239	0.618	0.455	0.198	0.201	120
United Kingdom	0.323	0.141	0.574	0.441	0.143	0.110	525
Overall[a]	0.413	0.208	0.959	0.263	0.255	0.113	238

[a] Decomposition between countries and regions, using averages over 2000-2014. The between and within shares are the ratio of the between or within group variance to the overall variance. The between and within ranges are the difference between the maximum and minimum observed values between or within groups.

the shares are close to even. In most countries, the majority of the variation occurs within regions. The exceptions are Belgium, Denmark, Finland, Ireland, and Sweden, where the variation between regions is larger. Moreover, in all countries the within range exceeds the between range. This implies that, in general, more extreme values are observed within regions than between regions.

Like the previous table, the last row summarizes a variance decomposition between countries and regions, using average values for 2000-2014. Like with the average rate, the variation between countries is larger than that within countries. However, the ranges of extreme values observed between and within countries are relatively closer. The difference between the highest and lowest marginal rates observed between countries is just over twice as large as the difference within countries. Regional differences in tax rates are thus quite substantial.

3.4.3 Relative Tax Rates

Another way to explore the variation across regions, particularly within countries, is to express the estimated tax rates relative to the country average. The regional distribution of the average tax rates, using average values for 2000-2014, is mapped in Figure 3.2. In this map, the lighter shades of gray correspond to regions where the average rate is lower than the national average, whereas the darker shades imply that the rate exceeds the average. A cursory inspection of the map immediately shows that there are substantial differences in tax rates within countries. The highest average rate within a country tends to be around 1.2 times the value of the lowest rate within that country. As noted before, however, there is a lot of variation across countries in regional dispersion of taxes.

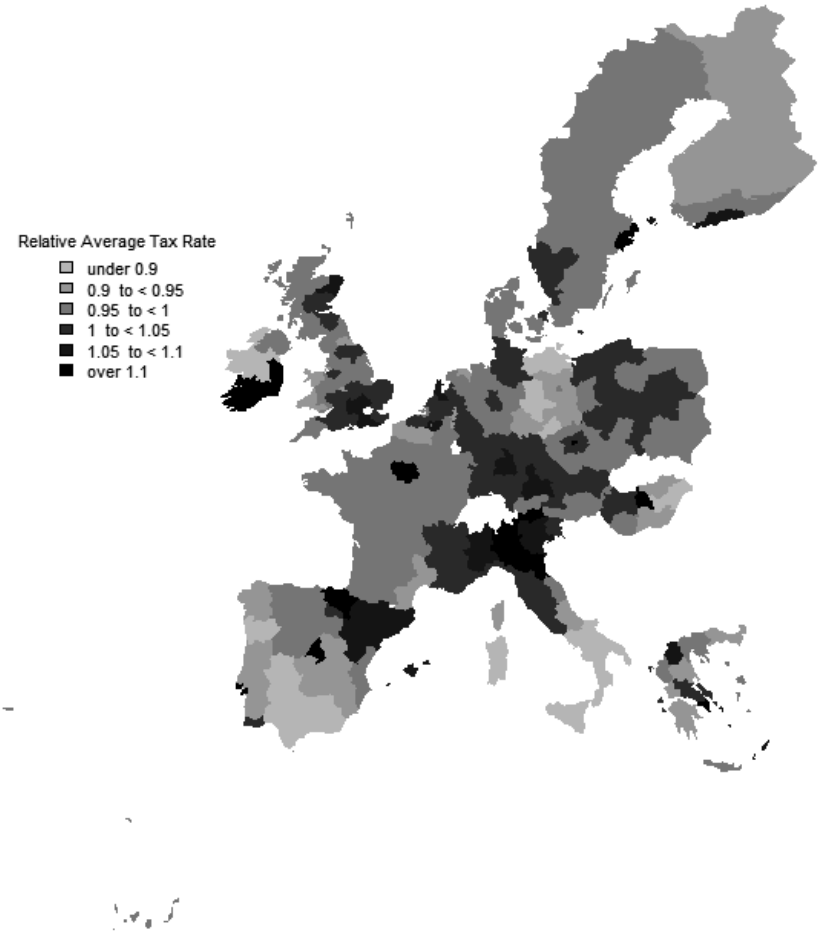


Figure 3.2: Relative Average Tax Rates

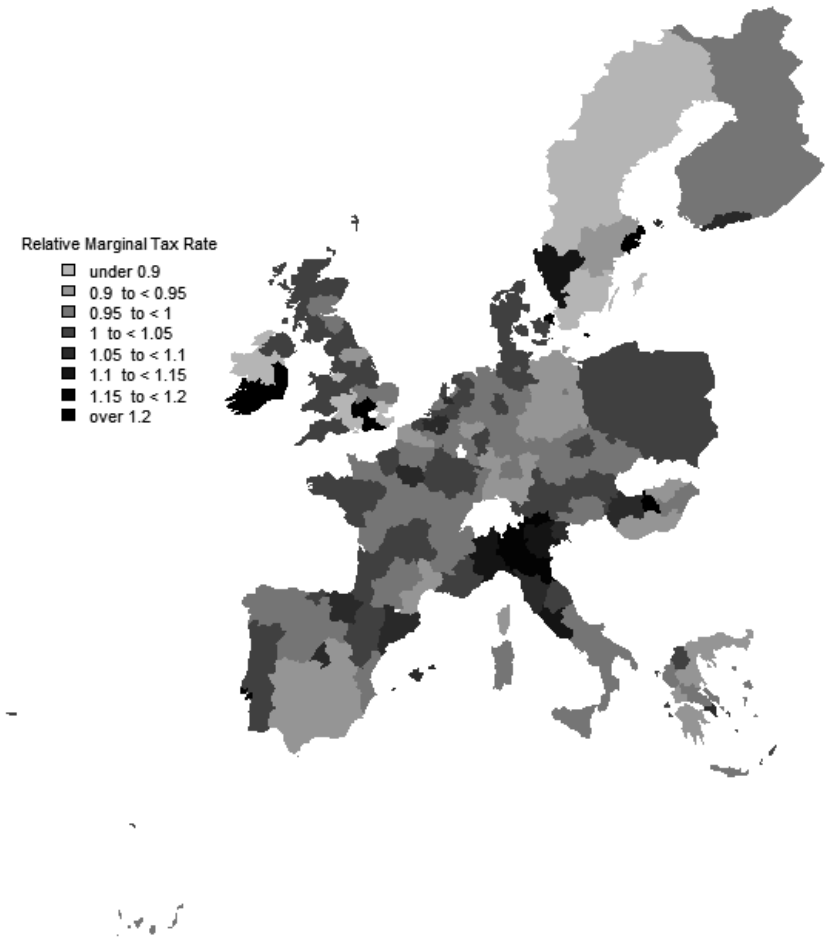


Figure 3.3: Relative Marginal Tax Rates

The biggest regional difference is observed in Spain. Here a citizen earning the average income in Extremadura paid around 17.1% of his income in taxes (between 2000-2014), whereas a citizen earning the average income in Madrid paid around 24.4%, which is 1.42 times as high. Similarly large differences (between 1.3-1.4 times) are observed in Italy, Hungary and Portugal. On the other end of the spectrum is Poland, where the difference between the lowest and highest average regional tax rate is only a factor 1.05. Austria and Denmark have similarly low degrees of variation, while for most other countries the difference is somewhere between a factor 1.15 and 1.25. This map thus very clearly stresses the point that there are substantial differences in tax rates between regions within countries. However, for these differences to materialize it is not sufficient that there are regional income

differences. The tax system must also be substantially progressive around those income levels typically observed within a country.

In Figure 3.3 the marginal tax rates are plotted in a similar fashion. Lighter shades of grey are again used to represent regions with tax rates below the national mean and darker shades for those with tax rates above the national mean.[11] In comparison with the relative average rates in Figure 3.2, it is clear that depending on the area examined the marginal rates show greater or smaller variation. This depends on exactly where the tax brackets lie relative to the regional income levels. In France, for example, the average rates in most of the country are quite similar, while the marginal rates show more variation. This occurs because the income differences are fairly small, yet the average income in some regions falls just into a higher tax bracket, resulting in a higher marginal rate while barely changing the average rate. In Poland, on the other hand, the opposite occurs. Income differences between Polish regions are quite small and the tax system consists of only a small number of tax brackets. As a result, all Polish regions face essentially the same marginal tax rate. Average rates do differ slightly, as a higher income level implies that a greater share of income falls in the highest tax bracket.

3.5 Explaining Regional Differences in Relative Tax Rates

There is substantial variation in relative tax rates across European regions, as highlighted above. This section explores what factors may explain this variation. For this purpose, a general-to-specific regression approach is used to examine which variables vary systematically with the relative tax rate. This provides some intuition as to what regions with a high relative rate have in common, besides the obvious factor of having a higher income level. Summary statistics for all variables discussed in this section are listed in Table 3.1.

There are many variables that could potentially be used for this exercise. Here I shall follow for the most part Beugelsdijk et al. (2017a) who have identified a set of variables related to physical geography (sea border, EU outside border, latitude), economic geography (distance to the economic center of the country, urbanization rate, population density, employment in science and technology), economic structure (regional GDP, agricultural labor share, oil production, the share of R&D in GDP), culture (trust, ethnic diversity), and institutions (regional quality of governance, communist past) of European regions. All of these variables have been shown to

[11] Compared to Figure 3.2, the color schedule used in Figure 3.3 is extended with the categories 1.1-1.15, 1.15-1.2 and over 1.2 to reflect that marginal rates have more extreme values than average rates.

Table 3.1: Descriptive Statistics

	Obs	Mean	Std. Dev.	Min	Max	Correlation Avg. Rate	Correlation Marg. Rate
Relative Average Tax Rate	235	0.994	0.061	0.811	1.204	1.000	0.596
Relative Marginal Tax Rate	235	0.998	0.078	0.837	1.518	0.596	1.000
Log Regional GDP per Capita	235	10.013	0.501	8.605	11.007	0.349	0.178
Agricultural Labor Share	235	0.057	0.064	0.000	0.341	-0.284	-0.118
Regional Institutional Quality	231	0.380	0.514	-1.200	1.713	0.158	-0.040
Post Communist	235	0.166	0.373	0.000	1.000	-0.116	-0.075
Urbanization Rate	235	0.355	0.286	0.000	1.582	0.242	0.175
Sea Border	235	0.494	0.501	0.000	1.000	-0.138	-0.023
EU Border	235	0.115	0.320	0.000	1.000	-0.028	-0.106
Distance to Economic Center	235	0.246	0.236	0.000	1.739	-0.378	-0.215
Log Oil Production	235	0.008	0.026	0.000	0.192	-0.093	-0.023
Latitude	235	48.665	5.921	28.353	66.439	0.085	-0.015
Average Years Schooling	235	11.167	1.028	7.870	13.041	0.243	-0.020
Employment in Science and Technology	235	0.263	0.064	0.121	0.486	0.393	0.167
R&D Share in GDP	233	0.015	0.012	0.001	0.071	0.252	0.017
Fertilty Rate	235	0.016	0.003	0.010	0.022	0.008	0.015
Log Population Density	235	5.042	1.152	1.132	8.762	0.246	0.152
Number of Ethnic Groups	235	2.039	1.101	1.000	6.000	-0.068	-0.025
Unemployment Rate	235	0.087	0.042	0.030	0.233	-0.445	-0.214
Hours Worked per Capita, 1000s	224	0.743	0.109	0.508	1.324	0.538	0.323
Participation Rate	235	0.630	0.056	0.452	0.753	0.385	0.110
Trust	230	0.454	0.123	0.074	0.807	0.141	0.076

All variables are in averages over the period 2000-2014.

be associated with regional economic development. In addition, I consider some variables particularly relevant for regional labor markets, being the fertility rate, the unemployment rate, the participation rate, and average years of schooling.

The descriptives in Table 3.1 show that a couple of variables have quite a strong correlation with the relative average tax rate. Specifically, the number of hours worked in per capita terms, the employment share of the science and technology sector, and the participation rate all have a relatively high positive correlation. Conversely, the unemployment rate, distance to the economic center, and the agricultural labor share have a fairly high negative correlation. What furthermore stands out from this table is that the correlations of the variables with the relative marginal tax rate tend to be of a smaller size than those with the average tax rate, although mostly with the same sign. This is indicative of the fact that regional variation in marginal tax rates is more difficult to explain, since marginal rates change in discrete steps and a small income change may place an average citizen of a region in a different marginal tax bracket.

3.5.1 Regression Results

To explore what regions with similar relative tax rates have in common a simple approach is a series of general-to-specific regressions. For purposes of exposition, a simplified version of the process described in Hoover and Perez (1999) is used as in Beugelsdijk et al. (2017a). Specifically, starting from the model with all variables included, the first step drops all variables with a P-value above 0.5. This step is repeated, if necessary, until the P-values of the remaining variables stay above 0.5. In the second step, all variables with a P-value above 0.1 are dropped. This step too is repeated as often as necessary. It is furthermore verified that the final specification arrived at in this manner would also be obtained if in each step only the least significant variable is dropped. All variables are included as averages over the period 2000-2014.

Table 3.2 summarizes the regression results for the relative average tax rate. In the first column all variables are included. Seven variables are significant to various degrees, mostly related to economic or physical geography and labor markets. Moreover, the R-squared is quite high at around 0.6, suggesting that the included variables describe the variation in relative average rates quite well. However, these results do not account for unobserved differences between the countries in which the regions are located. Including country dummies in column (2) changes the results substantially, as it essentially filters out the time-invariant country level factors. In column (3) all variables are dropped with a P-value above 0.5, leaving 12 variables. This step need not be reiterated, as all variables retain their significance at this

Table 3.2: Relative Average Rate Regressions

Dependent Variable	Relative Average Tax Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Log GDPpc	-0.0293	0.107	0.0753*	0.0955***	0.115***	0.123***
	(0.0441)	(0.0671)	(0.0368)	(0.0293)	(0.0279)	(0.0228)
Agri. Labor Share	-0.287*	-0.262**	-0.316***	-0.342**	-0.357**	-0.342**
	(0.141)	(0.0962)	(0.107)	(0.118)	(0.126)	(0.131)
Institutional Qual.	-0.00916	-0.000985				
	(0.0104)	(0.00691)				
Post Communist	-0.0552	-0.0676*	-0.0755***	-0.0553**	-0.0256	
	(0.0465)	(0.0329)	(0.0193)	(0.0217)	(0.0196)	
Urbanization Rate	0.0400	0.0210	0.0235			
	(0.0237)	(0.0153)	(0.0160)			
Sea Border	-0.00379	-0.00390				
	(0.00742)	(0.00690)				
EU Border	0.0191*	0.00395				
	(0.0100)	(0.0102)				
Dist. to Econ. Center	-0.0855**	-0.0289	-0.0219			
	(0.0392)	(0.0286)	(0.0225)			
Log Oil Production	0.0432	-0.0207				
	(0.154)	(0.100)				
Latitude	-0.00510***	-0.000336				
	(0.00151)	(0.00197)				
Avg. Years Schooling	0.0243**	0.0285	0.0307**	0.0198		
	(0.00998)	(0.0193)	(0.0118)	(0.0115)		
Emp. in Science/Tech.	0.295	0.0519				
	(0.204)	(0.226)				
R&D Share in GDP	-0.630	-0.600**	-0.339			
	(0.395)	(0.234)	(0.237)			
Fertility Rate	1.900	4.085	4.435			
	(2.685)	(3.412)	(3.210)			
Log Pop. Density	-0.0113***	-4.88e-05				
	(0.00352)	(0.00565)				
Ethnic Groups	0.00107	0.00274	0.00287			
	(0.00282)	(0.00240)	(0.00223)			
Unemployment Rate	-0.171	-0.428	-0.515*	-0.530***	-0.615***	-0.716***
	(0.237)	(0.278)	(0.250)	(0.145)	(0.181)	(0.129)
Hours Worked	0.279***	-0.0324				
	(0.0697)	(0.108)				
Participation Rate	0.0137	0.494**	0.509***	0.474***	0.474***	0.380***
	(0.124)	(0.181)	(0.164)	(0.146)	(0.155)	(0.104)
Trust	-0.0314	-0.0382	-0.0324			
	(0.0340)	(0.0289)	(0.0282)			
R^2	0.599	0.833	0.822	0.803	0.794	0.791
Regions	216	216	228	235	235	235
Countries	16	16	17	17	17	17

Estimated using OLS. All variables used are averages over the period 2000-2014. Cluster robust standard errors reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

level. In column (4) variables with a P-value above 0.1 are dropped. To obtain a specification in which the significance of the included variables no longer changes, this step is repeated twice in columns (5) and (6). In all cases the R-squared is quite high, at around 0.6 without the country dummies and around 0.8 when they are included, suggesting that the variables included capture most of the variation in relative average tax rates.

The resulting specification in the final column of Table 3.2 suggests that four variables are strongly related to the relative average tax rate. Regional GDP per capita comes out significantly: A higher income level generally implies a higher marginal tax rate (at least within countries), and so a higher average rate as well. The agricultural labor share is negatively related to the relative average tax rate, implying that regions where fewer people are employed in agriculture tend to have higher average tax rates compared to the national average. A higher relative rate is also associated with a lower unemployment rate and a higher participation rate. This thus implies that there are fewer people out of the labor force and more people gainfully employed in general in regions with a higher relative tax rate. While it should be stressed that these estimates should by no means be interpreted as being causal, they are suggestive of the fact that regions that perform better economically are also taxed at a higher rate, which is exactly what one would expect.

Table 3.3 repeats this exercise with the relative marginal tax rate. What is immediately obvious is that these are harder to explain since, as also noted above, they are more volatile. This can be seen by noting that in column (1) only one variable is significant and that the R-squared is substantially lower than for the same column in Table 3.2. Adding the country dummies in column (2) naturally increases the R-squared (which is still only about half of that in Table 3.2), but causes the last variable to lose its significance as well. In column (3) all variables with a P-value above 0.5 are dropped and once again in column (4). Then in columns (5) and (6) this is repeated for a P-value of 0.1. As seen in the final column, this leaves only two variables that are significant, being regional GDP per capita and the participation rate. A higher regional income level is thus generally associated with a higher marginal tax rate (relative to the country average). In addition a higher participation rate is also associated with a higher relative marginal tax rate.

These results for the relative average and marginal tax rates thus illustrate two main points. First, patterns in the relative marginal tax rate are substantially harder to explain than those for the relative average rate. Second, regions in which more people work, particularly outside the agricultural sector, and which have a higher output level tend to have a higher tax rate than their country's national average. All of these factors of course contribute towards an average individual having a higher income level, which is a pre-requisite for being taxed at a higher rate.

Table 3.3: Relative Marginal Rate Regressions

Dependent Variable	Relative Marginal Tax Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Log GDPpc	0.0327	0.0490	0.0695	0.0421	0.116**	0.121***
	(0.0677)	(0.0977)	(0.0811)	(0.0553)	(0.0426)	(0.0362)
Agri. Labor Share	-0.0391	-0.0221				
	(0.186)	(0.138)				
Institutional Qual.	-0.0192	-0.0120	-0.00747			
	(0.0157)	(0.0102)	(0.0122)			
Post Communist	0.00400	-0.0587	-0.0469**	-0.0422*	-0.0141	
	(0.0523)	(0.0405)	(0.0219)	(0.0230)	(0.0152)	
Urbanization Rate	0.0418	0.00978				
	(0.0339)	(0.0385)				
Sea Border	-0.00730	-0.0194	-0.0202*	-0.0157		
	(0.0134)	(0.0130)	(0.0109)	(0.0126)		
EU Border	-0.0239	-0.0294	-0.0270	-0.0254		
	(0.0217)	(0.0240)	(0.0226)	(0.0200)		
Dist. to Econ. Center	-0.0738	-0.0136				
	(0.0457)	(0.0388)				
Log Oil Production	0.0627	-0.0836				
	(0.182)	(0.244)				
Latitude	-0.00259	0.00176				
	(0.00173)	(0.00350)				
Avg. Years Schooling	-0.00345	0.0224	0.0197	0.0154		
	(0.0110)	(0.0242)	(0.0205)	(0.0189)		
Emp. in Science/Tech.	0.262	0.385	0.435	0.508		
	(0.301)	(0.503)	(0.451)	(0.382)		
R&D Share in GDP	-1.302	-1.682	-1.834*	-1.533		
	(0.856)	(1.088)	(0.958)	(0.919)		
Fertility Rate	4.442	0.302				
	(2.877)	(4.061)				
Log Population Density	-0.00806	0.00685	0.00741	0.00557		
	(0.00826)	(0.00892)	(0.00561)	(0.00567)		
Ethnic Groups	0.00633	0.00469	0.00470	0.00362		
	(0.00539)	(0.00532)	(0.00445)	(0.00431)		
Unemployment Rate	-0.0582	-0.0373				
	(0.273)	(0.268)				
Hours Worked	0.244***	-0.0554	-0.0570			
	(0.0738)	(0.139)	(0.131)			
Participation Rate	-0.222	0.604	0.588*	0.574**	0.524**	0.502***
	(0.209)	(0.347)	(0.315)	(0.266)	(0.185)	(0.171)
Trust	0.0542	0.0297				
	(0.0734)	(0.0646)				
R^2	0.240	0.435	0.430	0.432	0.373	0.375
Regions	216	216	218	233	235	238
Countries	16	16	16	17	17	17

Estimated using OLS. All variables used are averages over the period 2000-2014. Cluster robust standard errors reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.6 Taxes and Unemployment Rates

There is a rich literature that seeks to explain unemployment differences between countries. This literature has associated various labor market characteristics with differences in unemployment rates. One such feature is the rate of personal income taxation, which is typically found to be positively related to unemployment (Daveri & Tabellini, 2000; Hausman, 1981; Planas et al., 2007; Triest, 1990). Differences in unemployment within countries, however, tend to be of the same order of magnitude or even larger as differences between countries (Taylor & Bradley, 1997). One cannot rely on the set of factors identified in the macro-level research to explain regional unemployment differences, since institutions are typically the same for all regions within a country (Elhorst, 2003). For example, all regions in a certain country are subject to the same set of labor market regulations. Taxation has until now been placed in this category as well, since by and large the same tax code applies to all regions within a country equally. As shown in this chapter, however, income differences between regions, combined with progressive tax systems, lead to substantial differences in tax rates. One possible application of this dataset would thus be to examine the relationship between taxes and unemployment at the regional level.

For this purpose a simple approach is to regress the regional unemployment rate on the estimated regional tax rate (average or marginal) and a set of control variables. Specifically, the equation to be estimated would be

$$\mathrm{u}_{rt} = \lambda \mathrm{u}_{r,t-1}\alpha_r + \alpha_t + \beta\ \mathrm{tax}_{rt} + \gamma\mathbf{X} + \varepsilon_{rt}, \tag{3.1}$$

where tax can be either the average or marginal regional tax rate and $\mathbf{X}$ are the control variables. The subscripts r and t denote the region and year, respectively. A lag of the unemployment rate can be included to account for its possibly autocorrelated nature. This specification accounts for unobserved time-invariant differences between regions (and by extension, countries) by the inclusion of a region fixed effect, α_r. This accounts for many of the labor market institutions identified in the literature and thereby reduces the number of control variables that should be included. In addition, time-variant factors that affect all regions equally are controlled through a time fixed effect, α_t. As noted by Elhorst (2003), a similar reduced form specification can be obtained regardless of the exact underlying theoretical model of the labor market that is used.

The literature on regional unemployment has identified a number of control variables that should be included in any empirical analysis (Elhorst, 2003). The controls

[12] Elhorst (2003) notes that the relationship between regional GDP and unemployment should be interpreted with care, as it is not necessarily causal. However, given the clear relationship between taxes and income it is a desirable control here nonetheless.

to be included are regional GDP per capita[12] (Murphy, 1985), the participation rate (Elhorst & Zeilstra, 2007), the fertility rate (Olsen, 1994), average years schooling (Partridge & Rickman, 1995) and the agricultural labor share (Taylor & Bradley, 1997). In addition, regional unemployment rates are generally highly autocorrelated, so that it may be desirable to also include a lag of the unemployment rate (Chalmers & Greenwood, 1985; Elhorst, 2003).[13]

3.6.1 Regression Results

Table 3.1 reports the results when equation 3.1 is estimated by means of OLS. In the first column only average tax variables and regional GDP are included, all of which are highly significant at the 1% level. Regional GDP appears with a negative sign, suggesting that richer regions tend to have lower unemployment rates. Moreover, the average tax rate is positively correlated with the unemployment rate, in line with the existing research at the national level (Daveri & Tabellini, 2000).[14] These results are mostly unchanged when in the second column the additional control variables are included. Of these the participation rate is particularly significant and positive.[15] The fertility rate and average years schooling both have a marginally significantly negative relation with unemployment, whereas the agricultural labor share is not significant at all. Both tax variables appear with a slightly smaller coefficient than before, but are still highly significant. Lastly, in the third column a lag of the unemployment rate is included in the specification. As expected, this increases the fit of the model drastically, given its time-dependent nature. Its inclusion flips the sign on the fertility rate and causes average years schooling to lose its significance. Both participation rate and regional GDP retain their significance, but with a smaller coefficient. This is also true for the average tax rate, as its coefficient estimate is smaller but positive and highly significant at the 1% level.

The remaining columns of Table 3.1 report the results when this exercise is repeated for the marginal tax rate. In the fourth column only the marginal tax rate and regional GDP are included. Both of these are found to be highly significant and have the same sign as the results in the first column. The estimated coefficient

[13]Estimating a model with fixed effects and a lagged dependent variable by OLS is subject to so called dynamic panel bias (Nickell, 1981). Controlling for this by means of GMM, as suggested by Arellano and Bond (1991), does not change the results in any meaningful way and the results are therefore not reported.

[14]It should be noted that the sign of the relationship between unemployment and the tax variable is flipped when compared to Table 3.2. This occurs, however, because in Table 3.1 the actual tax rate is used, whereas in Table 3.2 the *relative* (compared to the national average) is used. By definition, the average region in any country has a relative tax rate of 1, yet the corresponding actual tax rate can vary widely across countries.

[15]As noted in Elhorst (2003), the effect of the participation rate on the unemployment rate is not clear a priori. Empirical studies have produced mixed results, although they they tend towards a negative relationship.

Table 3.1: Unemployment Rate Regressions

Dependent Variable	Unemployment Rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Average Tax Rate	0.438***	0.337***	0.137***			
	(0.0446)	(0.0481)	(0.0206)			
Marginal Tax Rate				0.127***	0.101***	0.0405***
				(0.0242)	(0.0223)	(0.0108)
Log Regional GDP per Capita	-0.164***	-0.122***	-0.0360***	-0.173***	-0.123***	-0.0347***
	(0.0131)	(0.0142)	(0.00612)	(0.0144)	(0.0154)	(0.00627)
Participation Rate		0.369***	0.248***		0.363***	0.239***
		(0.0869)	(0.0419)		(0.0876)	(0.0431)
Fertilty Rate		-3.478*	1.337*		-3.617*	1.356*
		(1.921)	(0.756)		(1.951)	(0.760)
Average Years Schooling		-0.0124*	0.00251		-0.00400	0.00625*
		(0.00675)	(0.00349)		(0.00665)	(0.00344)
Agricultural Labor Share		0.00163	-0.0430		0.0234	-0.0319
		(0.0744)	(0.0433)		(0.0860)	(0.0455)
Lagged Unemployment Rate			0.806***			0.823***
			(0.0254)			(0.0248)
R^2	0.434	0.356	0.743	0.381	0.322	0.738
Observations	3,392	2,572	2,389	3,392	2,572	2,389
Regions	237	234	234	237	234	234
Countries	17	17	17	17	17	17

Estimated using OLS with region and year fixed effects. Cluster robust standard errors reported in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

on the marginal rate is substantially lower than that on the average rate, however. This result is quite intuitive, as the marginal rate changes more easily than the average rate. Specifically, if an individual's income rises by such an amount that his marginal rate increases by e.g. five percentage points, his average rate will increase by much less than five percentage points. A percentage point change in the average rate is thus indicative of a larger change in the underlying factors (income, the tax schedule) than a percentage point change in the marginal rate. As such, one would expect a larger coefficient on the former. A similar finding is obtained in the fifth column, when the other control variables are added to the regression, which are found to have approximately the same sign and significance as in the analysis of the average rate. This is also true when the lag of the unemployment rate is included in the specification in the sixth column. As before, this generally has the effect of attenuating the estimated coefficients. The marginal tax rate, however, still has a positive coefficient which is highly significant at the 1% level.

Combined, these regressions highlight two main points. First, tax rates estimated at the regional level are valuable for an analysis of regional labor markets. Second, the observed positive relationship between taxation and unemployment is found at the regional level as well, for both average and marginal rates. This relationship is obtained while controlling for various covariates of regional unemployment as well as for unobserved differences between regions and countries. Moreover, this effect is obtained for both the average and the marginal tax rate. Finally, a change in the marginal rate is associated with a smaller change in unemployment than a change in the average tax rate of the same size.

3.7 Conclusion

This chapter has explored the importance and relevance of differences in average and marginal rates of personal income taxation at the regional level. A priori one may expect taxes to affect all regions within a country equally, which is the reason that taxation is not a topic usually considered from a regional perspective. As shown in this chapter, however, the implications need not be the same in every region. Specifically, there are large income differences between regions within the same country. Given that almost all countries have a system of progressive taxation, this implies that the average citizen in a low-income region may face a considerably lower average and marginal tax rate than one in a high-income region. In some countries, such as Spain, Portugal and Italy, an average income in the richest region is taxed at a rate which is 1.3-1.4 times as high as an average income in the poorest region. In other countries, where income differences are smaller or tax systems less progressive, these differences may be much smaller, yet still substantial.

This chapter has thus demonstrated that there is considerable variation in tax rates at the regional level. Moreover, it has shown that this variation can be linked to various key economic variables. Regions with tax rates higher than their country's average are found to share a number of characteristics. First, they tend to have a higher output level. Second, employment in the agricultural sector tends to be lower. Third, they have a lower unemployment rate and a higher participation rate. As such, it is generally the case that citizens in regions that perform better economically will also face a higher tax rate.

A second application of this new data set highlights the potential importance of taxation for studies of regional labor markets, where it has not previously been considered. As a first pass at the problem, the analysis conducted in this chapter suggests that there is a positive relationship between the regional unemployment and (average or marginal) tax rate. This is in line with existing work at the macroeconomic level (Daveri & Tabellini, 2000). A one percentage point increase in the average regional tax rate is associated with a 0.14 percentage point increase of the unemployment rate. Examining this relationship more carefully, e.g. using the methodology of Vega and Elhorst (2016), would be an interesting venue for future research. It would be particularly relevant to know if and how taxes affect regional unemployment differentials over time.

Both of the empirical exercises conducted in this chapter suggest studying taxes at the regional level may further our understanding of various regional economic phenomena. This understanding could be particularly relevant for policy makers. If taxes are relevant for regional economic performance, they affect the differences between regions. Taxes may, as in Kneller et al. (1999), reduce economic growth, or, as in Daveri and Tabellini (2000), increase unemployment. A common national tax policy imposes higher rates of taxation in high-income regions compared to low-income regions. Combined, this thus suggests that taxes may stimulate regional convergence, be it in income or labor market performance, since higher rates and thus stronger macroeconomic effects would be applied to regions with a higher income level. Such regional convergence is a key policy objective of the EU (European Political Strategy Centre, 2015), which may therefore want to consider the role of taxation in achieving its goals on this front.

As the Persians found in 484 B.C., a common taxation scheme may cause undesirable outcomes, such as protests and even rebellion in regions that bear the brunt of the policy. The data constructed in this chapter indicate that there is substantial variation in the average and marginal tax rates that apply to average individuals in different European regions. In modern day Europe, such differences are unlikely to have effects as severe as those in the Persian Empire. In fact, the effects could even be positive, if regional convergence is seen as a worthwhile endeavour. As is made

clear in this chapter, however, it cannot simply be assumed that national level tax policy does not have effects on differences between regions. A set of rules applied equally to all members of a group may still affect the differences between members.

Appendix Chapter 3

3.A Descriptions of Different Tax Systems

Taxes are generally levied according to the process explained in section 3.3 and as summarized in Table 3.1. There are, however, significant differences between countries in how complex their tax systems are, as well as in how frequently they are reformed. The complexities lie in a number of different areas. First, many forms of tax relief are linked to income and not always in a simple fashion. Second, there may be additional levies or surcharges that to some extent lie outside the regular tax framework. Third, in some cases there are complications in how the amount of taxable income is derived from an individual's gross wage. This appendix summarizes for each country these complexities. Here a distinction is drawn between issues that merely complicate the calculations, such as frequent tax reform or having a large number of tax brackets, and elements that differ more substantially. Where applicable the latter are listed as notable features of a specific country's tax system.

Austria

The Austrian tax system is relatively simple and not subject to frequent revisions. In 2004 and 2005, the number of tax brackets was reduced substantially in two steps to the current total of three separate tax brackets. A number of deductions apply and consist of primarily social security contributions as well as a fixed (i.e. not income dependent) amount. In addition, there is a small fixed tax credit that applies to everyone. Social security is levied over income up to a certain amount. From 2009 onwards, the unemployment insurance contribution consists of various income dependent brackets over which rates of 1, 2, or 3% are levied. Prior to 2009 this was a fixed rate of 3%.

Belgium

The Belgian tax system is fairly complex in that it contains a number of additional elements that are income dependent, as well as generally additional steps that have to be taken to compute the actual tax burden. In 2002 and 2003 the number of tax

brackets was reduced in two steps to four brackets. Complications lie in the fact that there is an income dependent deduction, social security contributions (which are also deductible) being levied in a not entirely linear fashion, and the presence of regional taxes.

Notable Features

Firstly, there is a deduction that consists of a fixed and variable part. In 2015 this deduction is approximately 2921 euros plus 3% of income (net of SSC) above 19390. These amounts are indexed and thus vary from year to year.

Secondly, social security is levied according to a base rate of 13.07% that applies to all income and is the same in all years. In addition, there is a so called special social security contribution that equals 223 euros plus 1.3% of all taxable income in excess of 21071 euros, up to a maximum op 731 euros. These values are the same in all years. Conversely, there is also a schedule for reductions of SSC. The exact amounts vary from year to year; for example, in 2015 there was a reduction of 2208 euros for individuals with an income of 18022 euros or less, that reduces to 0 as income rises to 28956 euros.

Lastly, Belgium has a form of regional taxation. Municipalities levy a surtax of around 7.5% (in 2015) over the computed tax burden of an individual. Municipalities can vary this surtax to a limited extent. However, since (1) data on actual municipal tax rates is not readily available, and (2) since there are many municipalities compared to NUTS 2 regions, only the average rate is used for the calculations.

Czech Republic

The Czech tax system has in recent years become very straightforward with the introduction of a flat tax system in 2008. The presence of a substantial and fixed tax credit, however, means the system is still somewhat progressive. Prior to 2008, the tax system consisted of four brackets (five before 2001). A further distinction can be drawn to the years before and after 2006. Before 2006, a fixed deduction applied to all income and there were no tax credits. From 2006 onwards, this is essentially reversed with the deductions being removed in favor of a fixed tax credit. Lastly, it should be noted that social security contributions are levied over all income at a fixed rate. Prior to 2008 and the introduction of the flat tax system, social security contributions were deductible. From 2008 onwards, this is no longer the case and in fact the system has moved in the opposite direction by also taxing social security contributions made by employers as regular income.

Notable Features

As noted above the treatment of SSC for purposes of deductions has changed substantially through the years. Employer SSC is considered income and thus taxed. In terms of the process described in Table 3.1, this thus means that the deduction is essentially negative. As a result, taxable income exceeds gross income.

Denmark

The Danish system is quite straightforward. It has a small number of tax brackets (two from 2010 onwards, three before) and deductions and tax credits that do not depend on income. Social security contributions are levied at a fixed rate and count as a deduction.

Notable Features

In Denmark the lion's share of taxes are levied at the municipal level. This complicates matters, since these rates vary by municipality for which data is not readily available. OECD (2000-2014) notes, however, that the variation is limited. Minimum and maximum values are within 3 percentage points of the average rate of around 25%. Furthermore, there are 99 municipalities in Denmark divided over 5 NUTS 2 regions, so when aggregated it is likely that these differences become smaller. Even so, it should be noted that the tax rates computed for Denmark thus understate the degree of regional variation.

Finland

The Finish tax system has most of the elements of a standard tax system. It has a relatively large number of tax brackets that extends to very high income levels (in excess of twice the national average). Over the years there have been a number of reforms, as the number of brackets was reduced in 2002 and 2007, and increased again in 2012. Social security contributions are only partially deductible and other deductions as well as tax credits tend to be income dependent.

Notable Features

From 2007 onwards, there is a tax credit that falls linearly as income rises. The exact parameters of this equation vary from year to year.

As noted above, SSC is only partially deductible. The cause here is a health care tax (1.32% in 2015) that is levied over a different tax base (specifically the municipal taxable income, defined below) and that is not deductible. Other elements of SSC are levied over the gross wage (at a rate of 7.13% in 2015) and are fully deductible.

As in Denmark, a large part of taxes is levied at the municipal level. Moreover, municipal taxes are levied over a different base than national level taxes, as different deductions apply to them. These municipal rates vary by a few percentage points around an average rate of around 20%. There are 77 municipalities divided over 5 NUTS 2 regions.

France

The French tax system is in essence fairly straightforward, although there are a couple of complications. The number of tax brackets was reduced (from 7 to 5) in 2007, with an additional bracket being temporarily used in 2012 and 2013. There are no tax credits (with the exception of individuals with very low incomes) and deductions are mostly computed in a simple manner. Social security is levied in a couple of brackets and counts as a tax deduction.

Notable Features

A more complicated factor is the universal social contribution (CSG) and the contribution to the reimbursement of social debt (CRDS). Combined these two amount to a fixed charge of 8% of the gross wage minus a small deduction. In 2000 it was levied over 95% of the gross wage, which has gradually been raised to 97.25% in 2014. Part of this contribution furthermore serves as a deduction for general taxation, but at a rate of 5.1% instead of the actual 8%.

An additional deduction exists for work related expenses. This deduction equals 10% of the remaining income after the deductions from social security, CGS and CRDS have been applied. An additional deduction of 20% of the income remaining after all other deductions were applied was in effect until 2006, after which it was essentially incorporated into the general tax schedule.

Germany

The German tax system is quite different from other tax systems in a variety of ways. The tax schedule is entirely formula based, income deductions generally depend on the income level, social security is levied in brackets, and there is a surcharge on top of general taxation. All of these elements are described in some detail below.

Notable Features

The main thing that sets the German tax system apart from other countries is its dependency on formulas instead of regular tax brackets. As an illustration, consider the formulas for the first two tax "brackets" (from 2015). First, if X is an individual's

income, define

$$Y = \frac{X - 8472}{10000}, \tag{3.2}$$

Then the income tax liability, T, can be computed as

$$T = 0 \text{ for } X \leq 8472 \tag{3.3}$$

$$T = (997.60Y + 1400)Y \text{ for } 8473 \geq X \leq 13469. \tag{3.4}$$

As such, this indicates that no taxes are due if an individual's income is below €8472. If an individual's income exceeds €8473 (but not €13469) the tax liability is a quadratic function of the rescaled income variable Y. For other income brackets (of which there are five in total) computations are similar. All of the parameters are typically changed from year to year.

Income deductions operate in a similar manner as in most tax systems and consist (for the most part) of a fixed part that is reduced as income rises. Before 2005, all social security contributions were deductible up to a maximum. This maximum deduction was gradually reduced as income rises, down to a minimum value. From 2005 onwards, social security contributions for healthcare are fully deductible and pension contributions partially.

Lastly, the German tax system features a solidarity surcharge which increases an individual's tax bill by a fixed 5.5%.

Greece

The Greek system has been frequently revised over the years, with tax brackets being added or removed regularly. In 2002 the number of brackets was reduced to 4 (from 6), which was increased to 9 in 2010, lowered to 8 in 2011, and lowered to 3 in 2013. Other elements of the tax system are fairly straightforward. Social security contributions are tax deductible and generally levied over all income up to a certain level. This threshold is set at roughly 3-4 times the average income, so that for most individuals SSC is paid over all income.

Notable Features

In 2012, Greece has introduced a so called solidarity contribution. This is essentially an additional tax that is levied over all income. This tax does not work with brackets, but increases at discrete intervals. For example, someone earning 50000 euros a year would have to pay an additional tax of 2% over all income. For someone earning 20000 euros this charge is instead 1% over all income. The exact rates and thresholds vary from year to year.

Hungary

In 2011, Hungary has introduced a system of flat taxation, where all income is simply taxed at a rate of 16%. The number of brackets had previously been reduced in 2005 to 2 (from 3). Moreover, since 2013 there are no notable deductions (including social security) and tax credits. Prior to 2013, there were various tax credits, which were phased out in 2011 and 2012. In addition, there are some complications regarding how taxable income is computed in some years.

Notable Features

In all years up to and including 2011, an income dependent tax credit was available. This tax credit was calculated in different ways in different years, however. For example, in 2000 the tax credit consisted of 36,000 Ft plus 2% of income, unless income exceeds 100,000 Ft, in which case the credit is 0. In other years instead the credit is either linearly reduced to 0 as income rises, or may be reduced in discrete steps.

In 2010 and 2011, SSC paid by employers is counted as income and taxed as such. This implies the deduction is essentially negative, and that the income which is taxed exceeds the gross wage. In 2012, the tax credit is abolished entirely and taxation of employer SSC is phased out. For the average tax payer these two effects essentially cancelled out: employer SSC no longer being tax led to a lower tax bill, whereas the abolishing of the tax credit increased it by approximately the same amount.

Ireland

The Irish tax system is very straightforward. There are only two tax brackets (three in 2010) and no deductions. There is a tax credit, but this is a fixed amount that does not depend on income in any way. In 2009 and 2010 Ireland instituted an additional income levy which has been incorporated into the tax schedule. To this a further "universal social charge" was added in 2011. Social security is levied in a system of brackets and is not deductible for general taxation.

Italy

The Italian tax system consists of five tax brackets (four in 2006). Social security is levied in two brackets and is tax deductible. A complication is an income-dependent tax credit that in some years is replaced with an income-dependent deduction.

Notable Features

In most years there is a tax credit that varies with income. Moreover, the details of this process vary from year to year. In general the credit is a (piecewise) linear function of income.

In the years 2003-2006 a similar (effectively almost identical) system was temporarily used in which the tax credit was replaced with an income deduction. This deduction is calculated in much the same way as the tax credit, but with different parameters.

Netherlands

There are a couple of factors that complicate the tax calculations for the Netherlands. There are four tax brackets, the first two of which consist almost entirely of social security levies. Tax credits and income deductions typically consist of a fixed and variable part. Some employer contributions furthermore contain elements that are typically counted as income by international statistical conventions, but that are not taxed under the Dutch system. These complications are described below.

Notable Features

Firstly, social security contributions are entirely levied through the regular tax schedule. In 2015, for example, the first tax bracket covers income from 0 to 19822 euros to which simultaneously a tax rate (of 8.35%) and a SSC rate (28.15%) apply. In the higher tax brackets on the other hand no SSC is levied, but instead a higher overal tax rate applies.

Second, parts of employer SSC are considered income by international definitions (and thus included in earnings estimates), but are not taxed under the Dutch tax system. A crucial distinction lies in (mandatory) health care contributions made by employers, which technically is a form of income but is not taxed. In practice, this means that these contributions have to be subtracted from the income estimate before taxes are computed, similar to a deduction.

Third, in 2002 there was a switch from a system that relied on having many income deductions to a system of tax credits. There are now two main tax credits, the so called general tax credit (available to everyone) and the work tax credit (available to everyone who works). Initially both of these tax credits were fixed amounts. In 2009, the work tax credit became income dependent by reducing it by 1.25% of all income earned above a certain threshold. In 2014, the general credit followed the same route. In both cases, the reduction of the tax credit increases up to a certain maximum.

Poland

The Polish tax system consists of two tax brackets (three prior to 2009). Tax credits are income dependent in a straightforward fashion. Social security contributions are (partially) deductible.

Notable Features

The tax credit consists of a fixed amount plus a percentage of income, with the exact numbers being subject to occasional revision. Social security contributions are only partially deductible, as health care contributions are excluded.

Portugal

The Portuguese tax system is for the most part straightforward. The number of tax brackets had been steadily increasing from five in 2000, to six in 2002, seven in 2007, to eight in 2010. In 2013 this trend was broken as the number of brackets was reduced to five. Tax credits and deductions are all fixed amounts. SSC is also a deduction and is levied at the same rate of 11% of all income in every year.

Notable Features

The only complication arises in the years 2011-2015, when an additional surtax has been installed. This tax is levied in addition to all other taxes and has its own rates and brackets.

Spain

The Spanish tax system has quite a number of tax brackets that have been subject to some revisions over the years. In 2003 the number of brackets was reduced to five (from six), and further to four in 2007. It was increased again to six in 2011, seven in 2012, and reduced again to five in 2015. Social security is tax deductible and a fixed percentage of all income. Other tax deductions and tax credits are all fixed amounts. The tax credits were introduced in 2007 and deductions reduced by a comparable amount.

Sweden

The Swedish tax system contains a couple of complex elements that have changed throughout the years. The number of brackets, however, is not one of these complexities, as it has remained at three throughout the entire period. Calculating deductions and tax credits, as well as SSC is more complicated, however, and ex-

plained below.

Notable Features

Over the years the manner in which social security contributions were treated for tax purposes has changed. Initially SSC (levied at a fixed rate of 7%) was an income deduction. From 2001 to 2005, a transition was made to SSC being a tax credit instead. From 2007 onwards, the income over which social security contributions are due was limited, however, this limit was set at an income level around 10% above the national average. Individuals at higher income levels thus pay less by means of SSC, but also receive a correspondingly lower tax credit.

Prior to 2003, the tax credit consisted of a fixed amount that was reduced as an individuals income rose. Later this was replaced with a system where the tax credit is essentially a fixed amount, although this amount is substantially increased for individuals with very low income (i.e. less than 60% of the national average).

Similar to the case of Denmark and Finland, income taxes are levied for a large part at the municipal level. In fact, the national level tax schedule is such that the average Swede does not pay any national level income taxes. Deductions and tax credits are shared between national and municipal taxes. A tax credit is thus applied to the total amount of taxes due, regardless of whether they are payable to the municipality or the national government. The municipal tax rates average around 32%, with minimum and maximum values within 3 percentage points. There are 290 municipalities divided across 8 NUTS 2 regions, so that variation in municipal rates may average out to a large extent at the NUTS 2 level. Even so, the rates estimated here will thus understate the extent of regional variation in Swedish tax rates.

United Kingdom

The tax system of the United Kingdom does not contain a lot of complicating factors. There are three tax brackets, except in 2008 and 2009, when there were two. Deductions and tax credits typically do not depend on income, unless income is very high (i.e. in excess of GBP $100,000$). Social security contributions are levied according to a simple schedule and are not deductible from income.